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The Forest Resources of the Hiawatha National Forest, 1993

Thomas Schmidt and Mike Lanasa

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Contents

The Forest Resources of the Hiawatha National Forest, 1993

Thomas Schmidt and Mike Lanasa

The Hiawatha National Forest is located in the central and eastern parts of the Upper Peninsula of Michigan (fig. 1). What makes the Hiawatha special are the kinds of natural resources found here, their unique arrangements, and the associated north-country climate. The Hiawatha National Forest consists of 892,100 acres and boasts of more than 777 miles of rivers and streams, 104 miles of shoreline, and 418 inland lakes. It is within a day's drive of Green Bay, Milwaukee, Chicago, Detroit, Minneapolis/St. Paul, and hundreds of other smaller communities. The combination of outstanding natural resources and closeness to highly populated regions has made the Hiawatha an important recreational attraction. Because the average snowfall ranges from 54 inches on the Forest's south shore to 240 inches or more on its north shore, people engage in winter sports here for nearly half of the year, primarily cross-country skiing, snowmobiling, ice fishing, hunting, and fur trapping.

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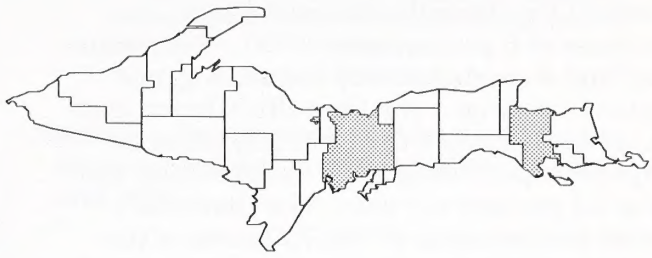

Figure 1.—*Location of the Hiawatha National Forest in the Upper Peninsula of Michigan.*

Three of the Great Lakes—Superior, Michigan, and Huron—have influenced the use of this peninsula by humans. This influence has been documented by archeology, by oral histories, and by the records of armies, missionaries, and governments. Native Americans influenced plant and animal communities through hunting, fishing, gathering, horticulture, and the use of fire. In the mid- to late-1800's, European immigration and resource exploitation caused major changes. Logging, and the fires that often followed, dramatically changed the area's vegetation. The current distribution, size, and abundance of various tree species are in many cases a direct result of these disturbances. However, the Hiawatha National Forest has recovered from these disturbances and today is entering a maturing stage.

Over the last five decades, the Forest Service has dedicated itself to managing National Forests with a multiple-use and sustained yield approach. However, an emerging global awareness and changes in society's expectations challenge us to re-examine this approach to resource management. As a result, we have shifted in focus from management of individual natural resources, such as timber, recreation, and wildlife, to management of the ecosystem and ecological landscapes of which those resources and species are a part. Ecosystem management on the Hiawatha National Forest is applied through five Ranger Districts located

across six counties within the Forest (the Rapid River and Manistique Ranger Districts have been combined since this survey was completed).

EXTENT OF FOREST LAND ON THE HIAWATHA NATIONAL FOREST

Forested land occupies more than 823,700 acres of the Hiawatha National Forest, an increase of 6 percent since 1980. The remaining land is predominately marsh, bog, and upland openings. The Hiawatha's forest land is productive; more than 815,000 acres are capable of producing more than 20 cubic feet of wood per acre per year. The Hiawatha's forest land consists of 756,700 acres of timberland, 58,300 acres of reserved timberland, and 8,700 acres of unproductive woodlands. The timberland total includes 298,700 acres of forest land not allocated for timber production in the Forest Plan (see the Hiawatha National Forest Plan for detailed information about operational land-use categories). A redistribution in forest land area occurred in reserved timberland between 1980 and 1993. Six areas, ranging in size from 378 to 12,230 acres, were designated components of the National Wilderness Preservation System in 1987.

Caution: Standard forest inventory definitions are necessary to consolidate or compare information from across the country, but they can sometimes give a misleading impression. For example, an area need only have 16.7 percent stocking of forest trees of any size, or formerly have had such tree cover, to be categorized as forest land. Much land that meets this definition on the Hiawatha is being maintained in an open condition primarily for wildlife and biodiversity reasons.

Most impressions of the Upper Peninsula of Michigan are of tall pines and spruces towering over the landscape. However, this region has a wide variety of forest types containing diverse species. In fact, 14 different forest types were found on the Hiawatha National Forest in 1993. The Forest has about half of its timberland in deciduous forest types (376,700 acres) and about half in coniferous forest types (380,000 acres). Of the coniferous forests, 168,900 acres were in pines and 211,100 acres were in other conifers. This diversity of forest types is due to the variety of land forms, soils, succession, previous management efforts by the Forest, and a host of other influences.

There were several changes in forest types between inventories. From 1980 to 1993, northern white-cedar, aspen, jack pine, elm-ash-red maple, white spruce, and paper birch all decreased in area (fig. 2). Some of the decreases are due to forest succession, as with aspen and paper birch. Many of these early successional forests resulted from wildfires 50 to 100 years ago. If not regenerated by harvesting or fire, these short-lived types undergo succession and progress into other longer lived forest types. As an example, aspen decreased from 113,500 acres in 1980 to 81,300 acres in 1993. These acres stayed forested, but they underwent plant succession to the point where they were reclassified as other forest types such as maple-birch.

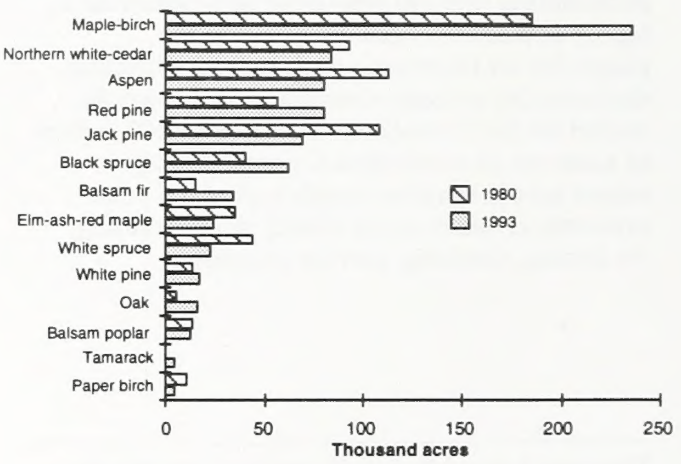

Figure 2.—*Area of timberland by forest type on the Hiawatha National Forest, 1980 and 1993.*

Early- to mid-successional forest types on the Hiawatha National Forest are jack pine, aspen, paper birch, and balsam poplar. Late successional forest types are red pine, white pine, white spruce, maple-birch, elm-ash-red maple, and oak. Swamp conifers, a third major kind of forest on the Hiawatha, include black spruce, balsam fir, northern white-cedar, and tamarack forest types.

Often, decreases in forest types, such as the elm-ash-red maple type, resulted from insects or diseases. Most of the larger elm trees on

the Hiawatha have been killed by the Dutch elm disease, and as a result, many of these stands have been reclassified to the maple-birch forest type. A similar decrease occurred with white spruce as a result of spruce budworm infestations. Many of the areas that had been spruce regenerated to the balsam fir forest type. The decrease in northern white-cedar is a concern on the Hiawatha. Some of the harvested northern white-cedar stands have regenerated to other forest types such as balsam fir, spruce, or balm-of-Gilead as a result of either browsing by an increasing deer herd, or inadequate site preparation. The Forest has intensified efforts to regenerate northern white-cedar.

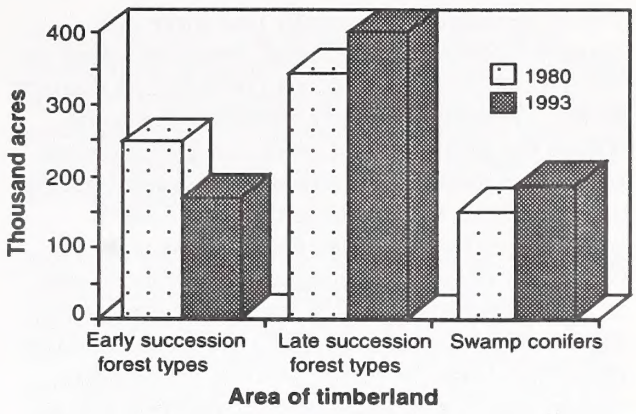

Figure 3.—*Area of timberland by successional stage on the Hiawatha National Forest, 1980 and 1993.*

Succession also led to decreases in certain forest types and increases in other types. In 1980, early- to mid-successional forest types accounted for 33 percent, late successional types accounted for 46 percent, and swamp conifers accounted for 20 percent of the timberland on the Forest (fig. 3). By 1993, the area occupied by those early- to mid-successional forest types had decreased to 22 percent, while the area occupied by late-successional forest types had increased to more than 53 percent. Swamp conifers increased to 25 percent of timberland between inventories.

COMPOSITION OF THE HIAWATHA'S FORESTS

The Hiawatha's forests contain more than 55 tree species and hundreds of other plants such as forbs, grasses, mosses, lichens, and sedges. The overstory woody plants dominate most sites and have a great influence on the existence of many of the understory plants. A tree is considered a woody plant having a perennial stem, a more or less definitely formed crown, and a height of at least 12 feet at maturity. In addition, to be counted in the total numbers of trees recorded in the inventory, a tree must have a d.b.h. of at least 1 inch. Northern white-cedar, with almost 74 million trees, was the predominant tree species in 1993 on the Hiawatha National Forest. Other common tree species were balsam fir, red maple, quaking aspen, sugar maple, black spruce, red pine, and jack pine (fig. 4). In total, there were almost 519 million trees on the Hiawatha in 1993, compared to 505 million trees in 1980.

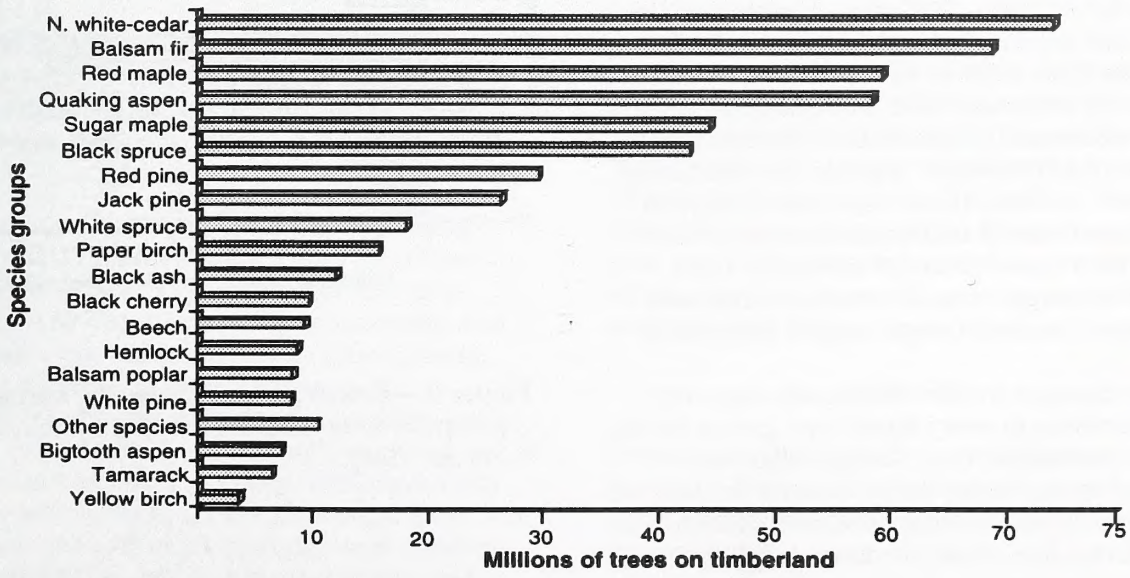

Figure 4.—*Number of trees by species group on timberland on the Hiawatha National Forest, 1993.*

Forest inventories generally use three size classes to describe the forest resource based on the average diameter (d.b.h.) of the predominant trees: 1) young, recently established stands where the predominant trees are 1 to 5 inches (sapling/seedling); 2) mid-size, well-established stands where the predominant trees are 5 inches to either 9 inches for coniferous or 11 inches for deciduous species (poletimber); and 3) sawtimber stands with trees that are greater than 9 or 11 inches. In 1980, 20 percent of the timberland was in young stands, 53 percent was in mid-size stands, and 27 percent was in sawtimber stands (fig. 5). By 1993, 32 percent of the timberland was in young stands, 28 percent was in mid-size stands, and 40 percent was in sawtimber stands.

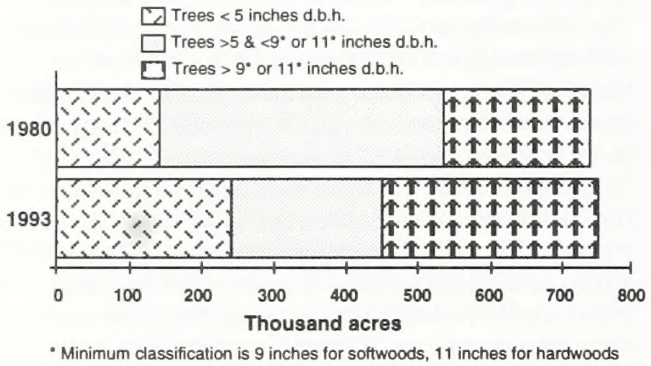

Figure 5.—*Area of timberland in 1980 and 1993 on the Hiawatha National Forest by stand-size class.*

The area of sawtimber increased dramatically in several forest types. Red pine, northern white-cedar, and aspen all showed increases in this size class from 1980 to 1993. There were some notable decreases as well. For example, white spruce decreased from 29,500 acres in 1980 to less than 5,000 acres in 1993 in the sawtimber size class. In total, there were about 940,000 trees more than 19 inches in diameter in 1980, compared to more than 1.3 million in 1993. Most of the larger trees on the Hiawatha were white pine, hemlock, sugar maple, and beech.

Notable changes in mid-size stands occurred with decreases in every forest type except for the elm-ash-red maple type. Large increases occurred in the maple-birch, balsam fir, and red pine forest types between 1980 and 1993 in the young forest size class (seedlings/saplings).

In 1993, 2 percent (18,100 acres) of the Hiawatha's timberlands were in either northern white-cedar or maple-birch stands older, on average, than 120 years. This does not include reserved forest land. In addition, scattered throughout the Hiawatha are individual trees that are at least 120 years old. These trees were not included in this classification because they did not dominate the stand to the level where they became the classified forest type.

The Hiawatha National Forest's net growing-stock volume increased from 863 million cubic feet in 1980 to more than 1 billion cubic feet in 1993. Between inventories, net growing-stock volume for the jack pine, white spruce, yellow birch, elm, aspen, and paper birch species groups decreased by an average of 25 percent. All other species groups increased in net growing-stock volume. Red pine increased the most, rising from about 82 million cubic feet in 1980 to almost 151 million cubic feet by 1993—an 83 percent increase (fig. 6). In 1993, red pine, red maple, sugar maple, and northern white-cedar were the only species groups accounting for more than 100 million cubic feet of growing-stock volume on the Hiawatha National Forest. These four species groups represented 50 percent of all volume on the Forest in 1993.

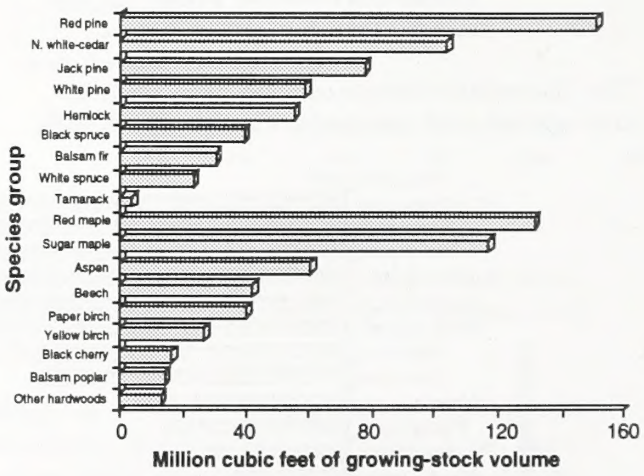

Figure 6.—*Growing-stock volume by species group on timberland on the Hiawatha National Forest, 1993.*

CAUSES OF CHANGE IN THE HIAWATHA'S FOREST RESOURCES

Forests constantly act and react to both internal and outside influences. The primary purpose of a forest inventory is to document those changes and analyze their impact on the health and productivity of the forest. Specific data elements of a forest inventory used to document change include growth, mortality, and removals.

Growth

Total annual gross growth on the Hiawatha National Forest averaged more than 34 million cubic feet for growing stock and more than 118 million board feet of sawtimber between 1980 and 1992 (fig. 7). (Caution: do not add the two growth figures because they are not cumulative; growing-stock growth includes sawtimber growth because sawtimber is considered as a part of growing stock.) Annual mortality averaged about 8 million cubic feet for growing stock and 18 million board feet for sawtimber.

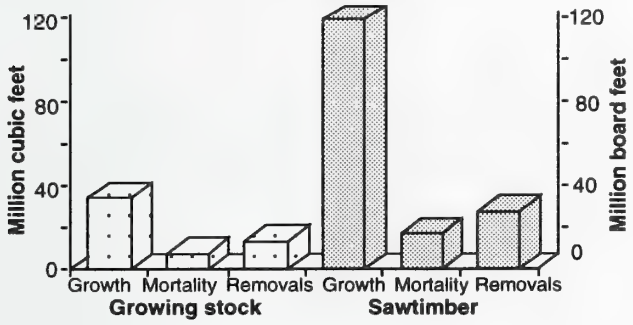

Figure 7.—*Annual gross growth, mortality, and removals of growing stock and sawtimber on timberland on the Hiawatha National Forest between 1980 and 1993.*

In addition, 13 million cubic feet of growing stock and 28 million board feet of sawtimber were removed from the Hiawatha annually between 1980 and 1992. When mortality and removals were subtracted from gross growth, the net increase in total volume on the Hiawatha averaged more than 13 million cubic feet of growing stock and 73 million board feet of sawtimber each year between 1980 and 1992. On the average acre on the Hiawatha, there was a net increase, after all mortality and removals were subtracted, of 18 cubic feet of growing stock per year. The growth to drain ratios (comparing growth to a combination of mortality and removals) average 2:1 for growing stock and more than 3:1 for sawtimber between 1980 and 1992, showing that the Hiawatha's forests are healthy and growing.

Conifers accounted for 62 percent of the average net annual growth (gross growth minus mortality) for growing stock between 1980 and 1993. Red pine alone accounted for 26 percent of all net growth on the Hiawatha between 1980 and 1992. Red and sugar maple were responsible for most of the growing-stock growth of deciduous species on the Hiawatha. All major species groups had more growing-stock growth than mortality and removals combined (fig. 8).

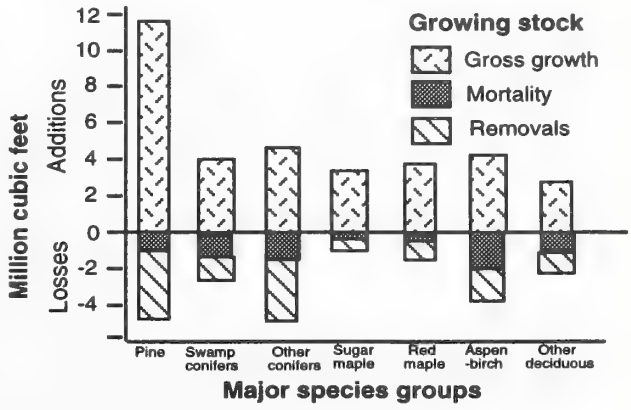

Figure 8.—*Average annual gross growth, mortality, and removals for growing stock on timberland between 1980 and 1992 on the Hiawatha National Forest.*

Sawtimber growth was similar to growing-stock growth; red pine showed the greatest growth, averaging more than 30 million board feet per year. White pine, sugar maple, and red maple all averaged between 9 and 10 million board feet of net growth per year on the Hiawatha. The pine species groups accounted for 46 percent of all net sawtimber growth, growing more than 46 million board feet per year (fig. 9).

Mortality

Average annual mortality on timberland on the Hiawatha National Forest was 23 percent of gross growth for growing stock and 15 percent for sawtimber.

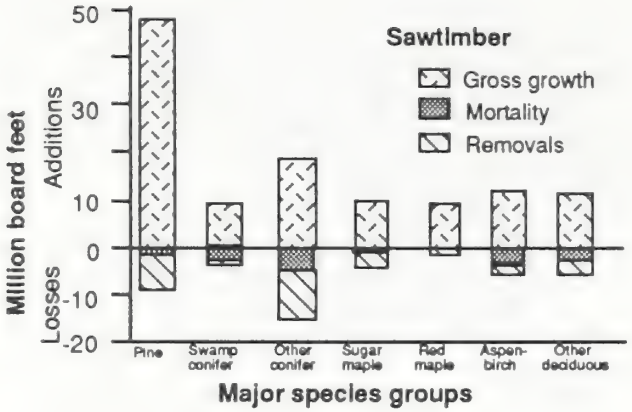

Figure 9.—*Average annual gross growth, mortality, and removals on timberland for sawtimber on the Hiawatha National Forest between 1980 and 1993.*

Most of the known causes of growing-stock mortality were stem decay, wind, white trunk rot, Dutch elm disease, nectria canker, bole borers, porcupines, and weather-related factors such as flooding.

In addition to tree mortality, some trees are damaged by insects, diseases, and abiotic factors but do not die. Frequently, the result of these agents are cracks, holes, and crooks in and on the tree, which lower the value of the tree for timber but can raise the value of the tree for wildlife. For example, many species of wildlife rely on decay fungi to create rotten pockets in older trees that can then be used for nesting as well as for feeding and roosting.

Removals

Average annual growing-stock removals of more than 1 million cubic feet per year on timberland occurred in the white spruce, jack pine, red pine, aspen, and red maple species groups. Sawtimber removals were highest for these same species groups plus white pine, yellow birch, sugar maple, and paper birch. These findings reflect harvesting for a wide variety of forest products. Harvesting, an important management aspect on the Hiawatha National Forest, contributes significantly to both the local and regional economies as well as to the lifestyle of the residents of the Upper Peninsula.

APPENDIX

***Note**: The 1993 inventory represents the fifth inventory of this region's forest resource. The four previous forest resource inventories are dated 1935, 1955, 1966, and 1980. Data from new forest inventories are often compared with data from earlier inventories to determine trends in forest resources. However, for the comparisons to be valid, the procedures used in the two inventories must be similar. As a result of our ongoing efforts to improve the inventory's efficiency and reliability, we have made several changes in procedures and definitions since the last Michigan inventory in 1980. Because some of these changes make it inappropriate to directly compare the 1993 data with those published for 1980, data from the 1980 inventory have been re-processed using the current procedures. Forest inventories completed before 1980 have not been adjusted to reflect current FIA inventory methodology and techniques. Comparisons between inventories should be general and used solely for analyzing trends. All area and volume data and tables were based on what existed as of January 1, 1993, in the Hiawatha National Forest. The time period used for growth, mortality, and removals was January 1, 1980, to December 31, 1992. The data in this report are subject to change; however, it is expected that any such changes will be minor.*

Accuracy of the Survey

Forest Inventory and Analysis (FIA) information is based on a sampling procedure. Consequently, the reported figures are estimates only. A measure of reliability of these figures is given by sampling errors. The level of sampling error used by FIA means the chances are two out of three that if a 100-percent inventory had been taken, using the same methods, the results would have been within the limits indicated. For example, the estimated growing-stock volume in the Hiawatha National Forest in 1993, 1,020.2 million cubic feet, has a sampling error of ± 4.46 percent (± 45.5 million cubic feet). Based on this sampling error, growing-stock volume from a 100-percent inventory would be expected to fall between 974.7 and 1,065.7 million cubic feet, there being a one in three chance that this is not the case. The sampling errors for the forest inventory of the Hiawatha National Forest in 1993 were:

Item	Unit totals	Sampling error
Growing stock	***Million cubic feet***	***Percent***
Volume (1993)	1,020.2	4.46
Average annual growth (1980-1992)	26.5	7.69
Average annual removals (1980-1992)	13.2	18.61
Sawtimber	***Million board feet***	
Volume (1993)	2,759.5	6.84
Average annual growth (1980-1992)	100.6	8.25
Average annual removals (1980-1992)	27.9	24.67
Area	***Thousand acres***	
Timberland (1993)	756.7	2.45

Care must be taken when using data from below the National Forest level because of increased sampling errors. For example, the sampling error for timberland area in a District or Management Area is higher than that for timberland area in the total National Forest. This tabulation shows the sampling errors for National Forest totals. To estimate sampling error for data smaller than National Forest totals, use the following formula:

$$\text{Error} = \frac{(\text{SE})\sqrt{\text{(National Forest total area or volume)}}}{\sqrt{\text{(Volume or area smaller than National Forest total)}}}$$

where: E = sampling error in percent
SE = National Forest total error for area or volume.

For example, to compute the error on the area of timberland in the maple-birch type for the National Forest:

1. Total area of timberland in the maple-birch forest type from table 3 = 236,100 acres;
2. Total area of all timberland in the National Forest from table 3 = 756,700 acres;
3. National Forest total error for timberland area from the above tabulation = 2.45 percent.

Using the above formula:

$$E = \frac{(2.45 \text{ percent})\ \sqrt{(756{,}700)}}{\sqrt{(236{,}100)}} = \pm 4.39 \text{ percent.}$$

Survey Procedures

The 1993 survey of the Hiawatha National Forest used a growth model-enhanced, two-phase sample design. Using this sampling scheme and associated estimators is similar to sampling with partial replacement, in that a set of randomly located plots is available for remeasurement and a random set of new plots is established and measured. A significant feature of the design is stratification for disturbance on the old sample and use of a growth model to improve regression estimates made on old undisturbed forest plots (fig. 10). Detailed descriptions of the sampling and estimation procedures are presented by Hansen (1990). The growth model used was the Lake States Stand and Tree Evaluation and Modeling System (STEMS) (Belcher *et al.* 1982).

Major Steps in the Survey Design

1. Aerial photography (Phase 1)

In this phase, two sets of random points were located on current aerial photographs. The first set was new photo plots, and the second set was relocated, old ground plot locations from the 1980 inventory. Locations of the plots used in the 1980 inventory were transferred to the new photographs. The photographs were then assembled into township mosaics, and a systematic grid of 121 one-acre photo plots (each plot representing approximately 190.4 acres) was overlaid on each township mosaic. Each photo plot was examined by aerial photogrammetrists and classified stereoscopically as to its land use. If trees were present, forest type and stand-size/density classes were recorded. All of the 1980 ground plot locations were also examined for disturbance (logging, fire, catastrophic mortality, etc.). After this examination, all the old "disturbed" sample locations and one-third of the old "undisturbed" forested plots were sent to the field for survey crews to verify the photo classification and to take further measurements. All photo plot locations for the 1993 inventory were examined and classified as shown in the tabulation on the following page.

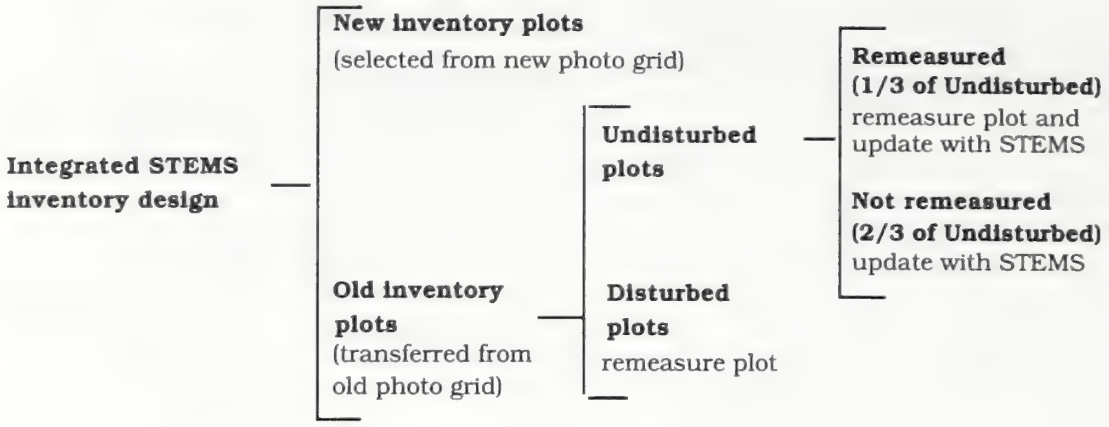

Figure 10.—Sample design for the Hiawatha National Forest 1993 survey.

Photo land class	Photo plots
Timberland	3,919
Reserved forest land	218
Other forest land	0
Questionable	243
Nonforest with trees	74
Nonforest without trees	285
Water	0
All classes	4,739

2. Plot measurements (Phase 2)

On plots classified as timberland, wooded pasture, or windbreak (at least 120 feet wide), a ground plot was established, remeasured, or modeled. Old plots that could not be relocated by field crews were replaced with a new plot at the approximate location of the old one. Each ground plot consisted of a 10-point cluster covering 1 acre. At each point, trees 5.0 inches or more d.b.h. were sampled on a 37.5 basal area factor variable-radius plot, and trees less than 5.0 inches d.b.h. were sampled on a 1/300-acre fixed-radius plot. The measurement procedure for both the new and old sample locations was:

a. New inventory plots

A random sample of new photo plots was selected for field measurement. Ground plots were established, and measures of current classification such as forest type, ownership, and size and condition of all trees on the plot, were recorded. These locations were monumented for future remeasurement.

b. Old inventory plots

These plots were originally established, monumented, and measured as part of the 1980 field inventory. Procedures for these old plots were different from those for the new plots. Old plots were classed as "undisturbed" or "disturbed" in the aerial photo phase of the sampling process. All disturbed plots and a one-third sample of the undisturbed forested plots were remeasured to obtain estimates of current condition and changes since the last inventory. All trees measured on these plots in 1980 were remeasured or otherwise accounted for, and all new trees were identified and measured.

All sample plots that were forested at the time of the 1980 inventory and determined to be undisturbed until the 1993 inventory were projected to 1993 using STEMS. This procedure gives projected estimates of current volume and growth for undisturbed plots. Comparison of the projected and observed values on the one-third sample of the undisturbed forest plots that were remeasured provided local calibration data to adjust the projected values of the undisturbed plots that were not remeasured. The adjustment procedure is a modified version of the method described by Smith (1983).

Undisturbed forested plots that were not remeasured played a crucial role in the new survey design. These plots, after careful comparison of past and current aerial photography, were determined to be undisturbed and had conditions that could be simulated by STEMS. The STEMS growth model was used to "grow"

the old plot and tree data to produce an estimate of current data. Thus, these plots were treated as ground plots, even though they were never visited. The plot record for each modeled plot was sent to the field for verification of current ownership information. All old plots classified as disturbed were sent to the field for remeasurement to assess and verify changes since the last inventory. Disturbance referred to any change on a plot that was detected on aerial photos and that the STEMS growth processor could not predict, such as catastrophic mortality, cutting, seedling stands, and/or land use change.

The estimation procedure for computing statistics from this sampling design was more complicated than the simple two-phase estimation procedure used in the past. In fact, this procedure yielded two independent samples, one coming from the new photo points and the other from the old photo points that were remeasured or modeled. The following tabulation summarizes the distribution of all ground plots for the new inventory design by type of plot:

Ground land use class	Old plots remeasured	Old plots updated	New plots	Total plots
Timberland	122	6	109	237
Reserved forest land	13	2	9	24
Nonforest with trees	0	0	6	6
Nonforest without trees	2	0	7	9
Total	137	8	131	276

3. Area estimates

Area estimates were made using two-phase estimation methods. In this type of estimation, a preliminary estimate of area by land use is made from the aerial photographs (Phase 1) and corrected by the plot measurements (Phase 2). A complete description of this estimation method is presented by Loetsch and Haller (1964).

4. Volume estimates

Estimates of volume per acre were made from the trees measured or modeled on the 10-point plots. Estimates of volume per acre were multiplied by the area estimates to obtain estimates of total volume. Net cubic foot volumes were based on a modification of the method presented by Hahn (1984) for use in the Lake States. The merchantable height equation presented was used in conjunction with Hahn's board foot volume equation (Hahn 1984) to estimate gross volume. This estimate was then corrected by species for variation in bark and cull volume to yield an estimate of net volume.

The Forest Service reports all board foot volume in International 1/4-inch rule. In Michigan, the Scribner log rule is commonly used. Scribner log rule conversion factors were derived from full tree measurements taken throughout the Lake States (Michigan, Wisconsin, and Minnesota) and an equation developed by Wiant and Castenaeda (1977). Factors, or multipliers, that can be used to convert board foot International volumes to the Scribner rule are shown in the tabulation below:

D.B.H. (inches)	Scribner rule conversion factor	
	Softwoods	Hardwoods
9.0-10.9	0.7830	—
11.0-12.9	.8287	0.8317
13.0-14.9	.8577	.8611
15.0-16.9	.8784	.8827
17.0-18.9	.8945	.8999
19.0-20.9	.9079	.9132
21.0-22.9	.9168	.9239
23.0-24.9	.9240	.9325
25.0-26.9	.9299	.9396
27.0-28.9	.9321	.9454
29.0+	.9357	.9544

5. Growth and mortality estimates

On remeasured plots, estimates of growth and mortality per acre come from the remeasured diameters of trees and from observation of trees that died between inventories. Growth reported as the average net annual growth between the two inventories (1980 and 1992) was computed from data on remeasurement plots and modeled plots using methods presented by VanDeusen *et al.* (1986). Mortality was also reported as average annual for the remeasurement period. On new plots, where trees were not remeasured, estimates of growth and mortality were obtained by using STEMS to project the growth and mortality of trees for 1 year. Growth and mortality estimates for old undisturbed plots that were updated were derived in the same manner as remeasured plots. The STEMS growth model was adjusted to meet local conditions, using data from the undisturbed remeasurement plots. As with volume, total growth and mortality estimates were obtained by multiplying the per acre estimates by area estimates. Current annual growth for 1992 was computed by using the adjusted STEMS model to grow all current inventory plots for 1 year.

6. Average annual removals estimates

Average annual growing-stock and sawtimber removals (1980 to 1992) were estimated only from the remeasured plots; new plots were not used to estimate removals. These estimates are obtained from trees measured in the last survey and cut or otherwise removed from the timberland base. Because remeasurement plots make up about one-half of the total ground plots, average annual removals estimates have greater sampling errors than volume and growth estimates.

Tree and Log Grades

On approximately one-third of the sample plots in the Hiawatha National Forest, all sawtimber sample trees were graded for quality and assigned either a tree grade (hardwoods) or a log grade (softwoods). Tree and log grades were based on the evaluation of external characteristics as indicators of quality. The volume yield by grade for this sample was used to distribute the volume of the ungraded sample trees by species group. Red pine and jack pine sawtimber trees were graded based on specifications described in "Forest Service log grades for southern pines" (Campbell 1964). White pine and other softwood sawtimber trees were graded according to specifications described in "Sawlog grades for eastern white pine" (Ostrander and Brisbin 1971). For all softwoods, the first merchantable 16-foot log, or shorter lengths down to 12 feet, was used for grading. Hardwood sawtimber trees were graded according to "Hardwood tree grades for factory lumber" (Hanks 1976). The best 12-foot section of the lowest 16-foot hardwood log was used for grading. Hardwood sawtimber trees that did not meet minimum tree grade specifications for grades 1 through 3 were assigned grade 4 according to Forest Service standard specifications for hardwood construction logs described in "A guide to hardwood log grading" (Rast *et al.* 1973).

Log Grades for Jack Pine and Red Pine [a]

Grade 1: Logs with three or four clear faces on the 16-foot grading section. [b]
Grade 2: Logs with one or two clear faces on the 16-foot grading section.
Grade 3: Logs with no clear faces on the 16-foot grading section.

After the tentative grade is established from above, the log will be reduced one grade for each of the following defects, except that no log can be reduced below grade 3. Net scale after deduction for defect must be at least 50 percent of the gross contents of the log.

1. **Sweep**. Degrade any tentative grade 1 or 2 log one grade if sweep amounts to 3 or more inches and equals or exceeds one-third of the diameter inside bark at the small end.
2. **Heart rot**. Degrade any tentative grade 1 or 2 log one grade if conk, punk knots, massed hyphae, or other evidence of advanced heart rot is found anywhere on the log.

[a] (Campbell 1964)

[b] A face is one-fourth of the circumference in width extending full length of the log. Clear faces are those free of: knots measuring more than one-half inch in diameter, overgrown knots of any size, and holes more than one-fourth inch in diameter. Faces may be rotated to obtain the maximum number of clear ones.

Log Grades for All Other Softwood Logs

Grade 1
1. Logs must be 16 inches d.i.b. or larger, 10 feet in length or longer, and with deduction for defect, not over 30 percent of gross scale.
2. Logs must be at least 75 percent clear on each of three faces.
3. All knots outside clear cuttings must be sound and not more than 2-1/2 inches in size.

Grade 2
1. Logs must be 12 inches d.i.b. or larger, 10 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross contents of the log.
2. Logs must be at least 50 percent clear on each of three faces or 75 percent clear on two faces.

Grade 3
1. Logs must be 6 inches d.i.b. or larger, 8 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross contents of the log.

Note: Diameters are d.i.b. at small end of grading section; percent clear refers to percent clear in one continuous section.

Eastern White Pine Saw-log Grade Specifications [a]

Grading factor	Log grade 1	Log grade 2	Log grade 3	Log grade 4
1. Minimum scaling diameter (inches)	14[b]	6	6	6
2. Minimum log length (feet)	10[c]	8	8	8
3. Maximum weevil injury (number)	None	None	2 injuries [d]	No limit
4. Minimum face requirements	Two full length or four 50%[e] length good faces (in addition, log knots on balance of faces shall not exceed size limit of grade 2 logs).	NO GOOD FACES REQUIRED Maximum diameter of log knots on three best faces: SOUND RED KNOTS not to exceed 1/6 scaling diameter and 3" maximum not to exceed 1/3 scaling diameter and 5" maximum OVERGROWN/DEAD/BLACK KNOTS not to exceed 1/12 scaling diameter and 1 1/2" max. not to exceed 1/6 scaling diameter and 2 1/2" max.		Includes all logs not qualifying for No. 3 or better and have at least 1/3 of their gross volume in sound wood suitable for manufacture into standard lumber
5. Maximum sweep or crook (%)	20	30	40	66 2/3
6. Maximum total scaling deduction (%)	50	50	50	66 2/3

AFTER THE TENTATIVE LOG GRADE IS ESTABLISHED FROM FACE EXAMINATION, THE LOG WILL BE REDUCED IN GRADE WHENEVER THE FOLLOWING DEFECTS ARE EVIDENT

7. Conks, punk knots, and pine borer damage on bark surface. [f]
   Degrade one grade if present on one face.
   Degrade two grades if present on two faces.
   Degrade three grades if present on three or more faces.
8. Log end defects: red rot, ring shake, heavy stain, and pine borer damage outside the heart center of log. [f] Consider log as having a total of 8 quarters (4 on each end) and degrade as indicated.
   Degrade one grade if present in 2 quarters of log ends.
   Degrade two grades if present in 3 or 4 quarters of log ends.
   Degrade three grades if present in 5 or more quarters of log ends.

a. (Ostrander and Brisbin 1971)
b. 12- and 13-inch logs with four full-length good faces are acceptable.
c. 8-foot logs with four full-length good faces are acceptable.
d. 8-foot Number 3 logs limited to one weevil injury.
e. Minimum 50% length good face must be at least 6 feet.
f. Factors 7 and 8 are not cumulative (total degrade based on more serious of the two). No log is to be degraded below grade 4 if net scale is at least one-third of gross scale.

Hardwood Tree Grades for Factory Lumber [a]

Grade factor	Tree grade 1	Tree grade 2	Tree grade 3
Length of grading zone (feet)	Butt 16	Butt 16	Butt 16
Length of grading section [b] (feet)	Best 12	Best 12	Best 12
D.b.h., minimum (inches)	16[c]	13	11
Diameter, minimum inside bark at top of grading section (inches)	13[c] 16 20	11[d] 12	8
Clear cuttings (on the 3 best faces):[e]			
Length, minimum (feet)	7 5 3	3 3	2
Number on face (maximum)	2	2 3	f
Yield in face length (minimum)	5/6	4/6	3/6
Cull deduction (including crook and sweep, but excluding shake) maximum within grading section (percent)	9	9[g]	50

a (Hanks 1976)

b Whenever a 14- or 16-foot section of the butt 16-foot log is better than the best 12-foot section, the grade of the longer section will become the grade of the tree. This longer section, when used, is the basis for determining the grading factors.

c In basswood and ash, diameter inside bark (d.i.b.) at top of grading section must be 12 inches and d.b.h. must be 15 inches.

d Grade 2 trees can be 10 inches d.i.b. at top of grading section if otherwise meeting surface requirements for small grade 1's.

e A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth of the surface of the grading section as divided lengthwise.

f Unlimited.

g Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2, if size and surface of grading section qualify as grade 1. If rot shortens the required clear cuttings to the extent of dropping the butt log to grade 2, do not drop the tree's grade to 3 unless the cull deduction for rot is greater than 40 percent.

Forest Service Standard Specifications for Hardwood Construction Logs Tie and Timber logs [a] [b]

Position in tree	Butts and uppers
Minimum diameter, small end	8 inches +
Minimum length without trim	8 feet +
Clear cuttings	No requirements
Sweep allowance	One-fourth small end d.i.b. for each 8 feet of length. One-half d.i.b. for logs 16 feet long.
Sound surface defects:	
Single knots	Any number, if no knot has an average diameter above the callus in excess of one-third of the log diameter at point of occurrence.
Whorled knots	Any number, if the sum of knot diameters above the callus does not exceed one-third of the log diameter at point of occurrence.
Holes	Any number not exceeding knot specifications as long as they do not extend over 3 inches into contained tie or timber.
Unsound defects :	
Surface	Same requirements as for sound defects if they extend into included timber. No limit if they do not.
Interior	None permitted except one shake not more than one-third the width of contained tie or timber, and one split, not over 5 inches.

a (Rast *et al.* 1973)

b These specifications are minimum for the class. If, from a group of logs, factory logs are selected first, thus leaving only nonfactory logs from which to select construction logs, then the quality range of the construction logs so selected is limited, and the class may be considered a grade. If selection for construction logs is given first priority, it may be necessary to subdivide the class into grades.

METRIC EQUIVALENTS OF UNITS USED IN THIS REPORT

1 acre = 4,046.86 square meters or 0.405 hectare.
1,000 acres = 405 hectares.
1 cubic foot = 0.0283 cubic meter.
1 foot = 30.48 centimeters or 0.3048 meter.
1 inch = 25.4 millimeters, 2.54 centimeters, or 0.0254 meter.
1 pound = 0.454 kilogram.
1 ton = 0.907 metric ton.

TREE SPECIES IN THE HIAWATHA NATIONAL FOREST[1]

SOFTWOODS

Balsam fir ..... *Abies balsamea*
Tamarack ..... *Larix laricina*
White spruce ..... *Picea glauca*
Black spruce ..... *Picea mariana*
Jack pine ..... *Pinus banksiana*
Red pine ..... *Pinus resinosa*
Eastern white pine ..... *Pinus strobus*
Northern white-cedar ..... *Thuja occidentalis*
Eastern hemlock ..... *Tsuga canadensis*

HARDWOODS

Sugar maple[2] ..... *Acer saccharum*
Red maple[3] ..... *Acer rubrum*
Yellow birch[2] ..... *Betula alleghaniensis*
Paper birch[3] ..... *Betula papyrifera*
American beech[3] ..... *Fagus grandifolia*
White ash[2] ..... *Fraxinus americana*
Black ash[3] ..... *Fraxinus nigra*
Green ash[2] ..... *Fraxinus pennsylvanica*
Butternut[3] ..... *Juglans cinerea*
Balsam poplar[3] ..... *Populus balsamifera*
Bigtooth aspen[3] ..... *Populus grandidentata*
Quaking aspen[3] ..... *Populus tremuloides*
Black cherry[3] ..... *Prunus serotina*
Swamp white oak[2] ..... *Quercus bicolor*
Northern red oak[2] ..... *Quercus rubra*
American basswood[3] ..... *Tilia americana*
American elm[3] ..... *Ulmus americana*

Noncommercial species

Striped maple ..... *Acer pennsylvanicum*
Mountain maple ..... *Acer spicatum*
Hawthorn ..... *Crataegus* spp.
Eastern hophornbeam ..... *Ostrya virginiana*
Canada plum ..... *Prunus nigra*
Pin cherry ..... *Prunus pensylvanica*
Wild plum ..... *Prunus* spp.
Chokecherry ..... *Prunus virginiana*
Willow spp. ..... *Salix* spp.

DEFINITION OF TERMS

Average annual removals from growing stock.—The average net growing-stock volume in growing-stock trees removed annually for forest products (including roundwood products and logging residues) and for other uses. Average annual removals of growing stock are reported for a period of several years (1980 through 1992 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Average annual removals from sawtimber.—The average net board foot sawtimber volume of live sawtimber trees removed annually for forest products (including roundwood products) and other uses. Average annual removals of sawtimber are reported for a period of several years (1980 through 1992 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Average net annual growth of growing stock.—The annual change in volume of sound wood in live sawtimber and poletimber trees and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes.

Average net annual growth of sawtimber.—The annual change in the volume of live sawtimber trees and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes.

Basal area.—Tree area, in square feet, of the cross section at breast height of a single tree. When the basal areas of all trees in a stand are summed, the result is usually expressed as square feet of basal area per acre.

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[1] *The common and scientific names are based on Little, Elbert L.*

[2] *This species or species group is considered a hard hardwood, with an average specific gravity greater than or equal to 0.50.*

[3] *This species or species group is considered a soft hardwood, with an average specific gravity of less than 0.50.*

Butt log.—The first 12 to 16 feet from a 1-foot stump that could be, or is, cut. Minimum standards for butt logs vary by species.

Clear panel.—A section of hardwood tree surface one-fourth the circumference of the tree and at least 2 feet long, free of limbs, knots, bumps, and other indications of defect that preclude clear cuttings.

Commercial species.—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam, osage-orange, and redbud.)

Cull.—Portions of a tree that are unusable for industrial wood products because of rot, missing or dead material, or other defect.

Diameter class.—A classification of trees based on diameter outside bark, measured at breast height (d.b.h.). Two-inch diameter classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

Diameter at breast height (d.b.h.).—The outside bark diameter at 4.5 feet (1.37 m) above the forest floor on the uphill side of the tree. For determining breast height, the forest floor includes the duff layer that may be present, but does not include unincorporated woody debris that may rise above the ground line.

Face.—A section of the tree surface one-fourth the circumference of the tree extending the full length of the log.

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparing specified standards with basal area and/or number of trees, age or size, and spacing.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas shall be classed as forest if less than 120 feet wide. (See definitions for Land, Timberland, Reserved forest land, Stocking, and Water.)

Forest type.—A classification of forest land based on the species forming a plurality of live tree stocking. Major forest types on the Hiawatha are:

Jack pine.—Forests in which jack pine comprises a plurality of the stocking. (Common associates include eastern white pine, red pine, aspen, birch, and maple.)

Red pine.—Forests in which red pine comprises a plurality of the stocking. (Common associates include eastern white pine, jack pine, aspen, birch, and maple.)

Eastern white pine.—Forests in which eastern white pine comprises a plurality of the stocking. (Common associates include red pine, jack pine, aspen, birch, and maple.)

Balsam fir.—Forests in which balsam fir and white spruce comprise a plurality of stocking with balsam fir the most common. (Common associates include white spruce, aspen, maple, birch, northern white-cedar, and tamarack.)

White spruce.—Forests in which white spruce and balsam fir comprise a plurality of the stocking with white spruce the most common. (Common associates include balsam fir, aspen, maple, birch, northern white-cedar, and tamarack.)

Black spruce.—Forests in which swamp conifers comprise a plurality of the stocking with black spruce the most common. (Common associates include tamarack and northern white-cedar.)

Northern white-cedar.—Forests in which swamp conifer species comprise a plurality of the stocking with northern white-cedar the most common. (Common associates include tamarack and black spruce.)

Tamarack.—Forests in which swamp conifers comprise a plurality of the stocking with tamarack the most common. (Common associates include black spruce and northern white-cedar.)

Oak-hickory.—Forests in which northern red oak, white oak, bur oak, or hickories, singly or in combination, comprise a plurality of the stocking. (Common associates include jack pine, beech, yellow-poplar, elm, and maple.)

Elm-ash-soft maple.—Forests in which lowland elm, ash, red maple, silver maple, and

cottonwood, singly or in combination, comprise a plurality of the stocking. (Common associates include birch, spruce, and balsam fir.)

Maple-birch.—Forests in which sugar maple, basswood, yellow birch, upland American elm, and red maple, singly or in combination, comprise a plurality of the stocking. (Common associates include birch, spruce, and balsam fir.)

Aspen.—Forests in which quaking aspen or bigtooth aspen, singly or in combination, comprise a plurality of the stocking. (Common associates include balsam poplar, balsam fir, and paper birch.)

Paper birch.—Forests in which paper birch comprises a plurality of the stocking. (Common associates include maple, aspen, and balsam fir.)

Balsam poplar.—Forests in which balsam poplar comprises a plurality of the stocking. (Common associates include aspen, elm, and ash.)

Growing-stock tree.—A live tree of commercial species that meets specified standards of size, quality, and merchantability. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.—Net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a minimum 4.0-inch top diameter (outside bark) of the central stem or to the point where the central stem breaks into limbs.

Hard hardwoods.--Hardwood species with an average specific gravity greater than 0.50 such as oaks, hard maple, and hickories.

Hardwoods.—Dicotyledonous trees, usually broad-leaved and deciduous. (See Soft hardwoods and Hard hardwoods.)

Land.—*A. Bureau of the Census.* Dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains; streams and sloughs less than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

B. Forest Inventory and Analysis. The same as the Bureau of the Census, except minimum width of streams, etc., is 120 feet and minimum size of lakes, etc., is less than 1 acre.

Live trees.—Growing-stock, rough, and rotten trees 1.0 inch d.b.h. and larger.

Log grade.—A log classification based on external characteristics as indicators of quality or value. (See Appendix for specific grading factors used.)

Merchantable.—Refers to a pulpwood or saw-log section that meets pulpwood or saw-log specifications, respectively.

Mortality.—The volume of sound wood in growing-stock and sawtimber trees that die annually.

National Forest land.—Federal land that has been legally designated as National Forest or purchase units, and other land administered by the USDA Forest Service.

Net volume.—Gross volume less deductions for rot, sweep, or other defect affecting use for timber products.

Noncommercial species.—Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products. Classified in volume tables as rough trees.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 39.9- acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area to qualify as nonforest land.)

a. Nonforest land without trees.—Nonforest land with no live trees present.

b. Nonforest land with trees.—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Nonstocked land.—Forest land less than 16.7 percent stocked with live trees.

Poletimber stand.—(See Stand-size class.)

Poletimber tree.—A tree of commercial species at least 5.0 inches d.b.h. but smaller than sawtimber size (9 inches d.b.h. for softwoods, 11 inches d.b.h. for hardwoods).

Potential productivity class.—A classification of forest lands in terms of inherent capacity to grow crops of industrial wood. The class identifies the potential growth in merchantable cubic feet/acre/year at culmination of mean annual increment of fully stocked natural stands.

Reserved forest land.—Forest land withdrawn from timber utilization through statute, administrative regulation, designation, or exclusive use for Christmas tree production, as indicated by annual shearing.

Rotten tree.—A tree that does not meet regional merchantability standards because of excessive unsound cull.

Rough tree.—A tree that does not meet regional merchantability standards because of excessive sound cull. May include noncommercial tree species.

Roundwood products.—Logs, bolts, or other round sections (including chips from roundwood) cut from trees for industrial or consumer uses. (Note: Includes saw logs, veneer logs, and bolts; cooperage logs and bolts; pulpwood; fuelwood; pilings; poles; posts; hewn ties; mine timbers; and various other round, split, or hewn products.)

Salvable dead tree.—A standing or down dead tree considered merchantable by regional standards.

Sapling.—A live tree 1.0 to 5.0 inches d.b.h.

Sapling-seedling stand.—(See Stand-size class.)

Saw log.—A log meeting minimum standards of diameter, length, and defect. A saw log must be at least 8 feet long, sound, straight, have a minimum diameter outside bark (d.o.b.) of 7.0 inches for softwoods and 9.0 inches for hardwoods, or have other combinations of size and defect specified by regional standards.

Saw-log portion.—That part of the bole of sawtimber trees between the stump and the saw-log top.

Saw-log top.—The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw-log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber stand.—(See Stand-size class.)

Sawtimber tree.—A tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d.b.h. Hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume.—Net volume of the saw-log portion of live sawtimber in board feet, International 1/4-inch rule (unless specified otherwise), from the stump to a minimum 7-inch top d.o.b. for softwoods and a minimum 9-inch top d.o.b. for hardwoods.

Seedling.—A live tree less than 1.0 inch d.b.h. that is expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Site index.—An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Soft hardwoods.—Hardwood species with an average specific gravity less than 0.50 such as gum, yellow-poplar, cottonwood, red maple, basswood, and willow.

Softwoods.—Coniferous trees, usually evergreen, having needles or scale-like leaves.

Stand.—A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-age class.—Age of main stand. Main stand refers to trees of the dominant forest type and stand-size class.

Stand-size class.—A classification of stocked (see Stocking) forest land based on the size class of live trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

a. Sawtimber stands.—Stands with half or more of live stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

b. Poletimber stands.—Stands with half or more live stocking in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

c. Sapling-seedling stands.—Stands with more than half of the live stocking in saplings and/or seedlings.

Stocking.—The degree of occupancy of land by live trees, measured by basal area; and/or the number of trees in a stand by size or age and spacing, compared to the basal area; and/or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard.

A stocking percent of 100 indicates full utilization of the site and is equivalent to 80 square feet of basal area per acre in trees 5.0 inches d.b.h. and larger. In a stand of trees less than 5.0 inches d.b.h., a stocking percent of 100 would indicate that the present number of trees is sufficient to produce 80 square feet of basal area per acre when the trees reach 5.0 inches d.b.h.

Stands are grouped into the following stocking classes:

Overstocked stands.—Stands in which stocking of live trees is 133 percent or more.

Fully stocked stands.—Stands in which stocking of live trees is from 100.0 to 132.9 percent.

Medium stocked stands.—Stands in which stocking of live trees is from 60.0 to 99.9 percent.

Poorly stocked stands.—Stands in which stocking of live trees is from 16.7 to 59.9 percent.

Nonstocked areas.—Timberland on which stocking of live trees is less than 16.7 percent.

Timberland.—Forest land that is producing, or capable of producing, in excess of 20 cubic feet per acre per year of industrial wood crops under natural conditions. In addition, the forest land must not be withdrawn from timber utilization, and not associated with urban or rural development. Currently inaccessible and inoperable areas are included.

Tree.—A woody plant usually having one or more perennial stems, a more or less definitely formed crown of foliage, and a height of at least 12 feet at maturity.

Tree grade.—A tree classification based on external characteristics as indicators of quality or value, used for hardwood species. (See Appendix for specific grading factors used.)

Tree size class.—A classification of trees based on diameter at breast height, including sawtimber trees, poletimber trees, saplings, and seedlings.

Unproductive forest land.—Forest land incapable of producing 20 cubic feet per acre per year of industrial wood under natural conditions because of adverse site conditions. (Note: Adverse conditions include sterile soils, dry climate, poor drainage, high elevation, steepness, and rockiness).

Upper stem portion.—That part of the bole of sawtimber trees above the saw-log top to a minimum top diameter of 4.0 inches outside bark, or to the point where the central stem breaks into limbs.

Water.—*(a) Bureau of the Census.*—Permanent inland water surfaces, such as lakes, reservoirs, and ponds at least 40 acres in area; and streams, sloughs, estuaries, and canals at least one-eighth of a statute mile wide.

(b) Noncensus.—Permanent inland water surfaces, such as lakes, reservoirs, and ponds from 1 to 39.9 acres in area; and streams, sloughs, estuaries, and canals from 120 feet to one-eighth of a statute mile wide.

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Table 1.--Area by county and major land-use class,
Hiawatha National Forest, Michigan, 1993

(In thousand acres)

County	Total land area	Forest land				Non-forest land
		All forest land	Timber-land	Reserved timber-land	Other forest land	
Alger	127.3	121.9	105.3	13.2	3.4	5.4
Chippewa	244.0	225.0	204.0	17.4	3.6	19.0
Delta	241.6	220.6	218.9	-	1.7	21.0
Mackinac	151.7	141.8	119.6	22.2	-	9.9
Schoolcraft	122.5	109.4	103.9	5.5	-	13.1
Marquette	5.0	5.0	5.0	-	-	-
All counties	892.1	823.7	756.7	58.3	8.7	68.4

Note: The timberland total includes 298,700 acres identified in the Forest Plan as "reserved" land that had not been located on the ground before this survey.

Table 2.--Area of timberland by forest type and stand size,
Hiawatha National Forest, 1993

(In thousand acres)

Forest type	All stands	Stand-size class		
		Sawtimber	Poletimber	Seedling & sapling
Jack pine	69.9	22	45	2.9
Red pine	81.3	52.1	7.9	21.3
White pine	17.7	17.7	-	-
Balsam fir	35.3	5.2	7.3	22.8
White spruce	23.6	4.8	9.3	9.5
Black spruce	62.7	12.7	11.7	38.3
Northern white-cedar	84.3	22.4	46.8	15.1
Tamarack	5.2	-	-	5.2
Oak-hickory	16.7	-	2.0	14.7
Elm-ash-soft maple	24.8	2.2	14.3	8.3
Maple-birch	236.1	134.7	44.6	56.8
Aspen	81.3	22.2	15.2	43.9
Paper birch	4.8	4.8	-	-
Balsam poplar	13.0	2.6	4.5	5.9
All types	756.7	303.4	208.6	244.7

Table 3.--Area of timberland by forest type and stand-age class, Hiawatha National Forest, 1993

(In thousand acres)

Species group	All ages	Stand-age class (years)												
		1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
Jack pine	69.9	-	2.9	5.0	15.1	12.1	28.9	3.0	-	2.9	-	-	-	-
Red pine	81.3	-	15.7	4.7	17.7	27.5	11.6	4.1	-	-	-	-	-	-
White pine	17.7	-	-	-	-	-	5.0	9.1	-	-	0.4	3.2	-	-
Balsam fir	35.3	18.2	-	2.3	-	9.6	-	-	-	-	-	5.2	-	-
White spruce	23.6	-	2.9	6.6	-	7.3	2.0	4.8	-	-	-	-	-	-
Black spruce	62.7	2.9	6.9	26.7	13.5	10.4	-	-	-	-	-	2.3	-	-
Northern white-cedar	84.3	2.1	-	3.7	15.8	11.7	14.6	6.7	3.8	11.0	2.8	6.2	2.9	3.0
Tamarack	5.2	-	1.8	-	-	3.4	-	-	-	-	-	-	-	-
Oak-hickory	16.7	-	14.7	-	-	2.0	-	-	-	-	-	-	-	-
Elm-ash-soft maple	24.8	2.2	6.1	-	-	4.6	8.7	-	3.2	-	-	-	-	-
Maple-birch	236.1	23.9	23.1	-	17.1	31.2	19.9	27.8	26.3	25.5	18.1	11.0	9.3	2.9
Aspen	81.3	16.8	23.6	3.5	6.3	12.4	6.4	10.0	-	2.3	-	-	-	-
Paper birch	4.8	-	-	-	-	-	-	-	4.8	-	-	-	-	-
Balsam poplar	13.0	5.9	-	2.1	-	2.4	-	-	-	-	2.6	-	-	-
All species	756.7	72.0	97.7	54.6	85.5	134.6	97.1	65.5	38.1	41.7	23.9	27.9	12.2	5.9

Table 4.--Area of timberland by forest type and potential productivity class, Hiawatha National Forest, 1993

(In thousand acres)

Forest type	All classes	120+ cu. ft.	85-119 cu. ft.	50-84 cu. ft.	Less than 49 cu. ft.
Jack pine	69.9	-	-	21.2	48.7
Red pine	81.3	19.1	36.1	26.1	-
White pine	17.7	-	6.1	4.9	6.7
Balsam fir	35.3	5.4	16.5	2.3	11.1
White spruce	23.6	-	7.7	15.9	-
Black spruce	62.7	-	-	23.4	39.3
Northern white-cedar	84.3	-	-	15.6	68.7
Tamarack	5.2	-	-	-	5.2
Oak-hickory	16.7	-	-	5.3	11.4
Elm-ash-soft maple	24.8	-	-	-	24.8
Maple-birch	236.1	-	37.8	132.7	65.6
Aspen	81.3	-	17.7	37.6	26.0
Paper birch	4.8	-	-	4.8	-
Balsam poplar	13.0	-	4.2	8.8	-
All types	756.7	24.5	126.1	298.6	307.5

Table 5.--Area of timberland by forest type and stocking class of growing-stock trees, Hiawatha National Forest, 1993

(In thousand acres)

Forest type	All classes	Stocking class		
		Poorly stocked	Moderately stocked	Fully stocked
Jack pine	69.9	5.6	25.1	39.2
Red pine	81.3	-	10.5	70.8
White pine	17.7	-	1.3	16.4
Balsam fir	35.3	13.8	6.8	14.7
White spruce	23.6	-	6.6	17.0
Black spruce	62.7	-	15.2	47.5
Northern white-cedar	84.3	7.6	4.7	72.0
Tamarack	5.2	-	5.2	-
Oak-hickory	16.7	-	-	16.7
Elm-ash-soft maple	24.8	-	3.8	21.0
Maple-birch	236.1	-	9.4	226.7
Aspen	81.3	3.5	12.8	65.0
Paper birch	4.8	-	4.8	-
Balsam poplar	13.0	2.1	2.1	8.8
All types	756.7	32.6	108.3	615.8

Table 6.--Number of all live trees on timberland by species group and diameter class, Hiawatha National Forest, 1993

(In thousand trees)

Species group	All classes	Diameter class (Inches at breast height) 1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
Jack pine	26,295	3,927	5,193	8,598	5,948	1,913	582	97	21	12	-	4	-
Red pine	29,436	7,419	6,972	4,282	3,246	3,357	2,525	1,202	273	76	41	43	-
White pine	8,105	2,958	1,227	1,006	920	674	403	291	229	136	99	153	9
White spruce	17,992	9,732	5,541	1,110	530	572	310	116	45	21	9	6	-
Black spruce	42,449	20,192	13,130	6,366	2,026	498	165	68	-	-	-	4	-
Balsam fir	68,692	53,394	8,661	3,932	1,886	702	80	19	9	9	-	-	-
Hemlock	8,541	3,435	1,344	809	836	601	526	420	179	174	91	124	2
Tamarack	6,338	4,305	1,410	440	72	46	12	27	18	4	4	-	-
Northern white-cedar	73,806	29,295	18,493	13,949	7,651	2,730	1,050	421	154	39	17	5	2
Total	281,654	134,657	61,971	40,492	23,115	11,093	5,653	2,661	928	471	261	339	13
Hardwoods													
White oak	15	-	-	-	-	15	-	-	-	-	-	-	-
Red oak	961	120	258	86	321	125	22	16	9	3	-	1	-
Basswood	577	21	72	99	213	88	45	15	10	8	-	6	-
Beech	9,286	4,110	1,614	1,131	662	268	386	521	288	138	74	94	-
Yellow birch	3,526	423	558	443	809	403	276	172	176	145	68	48	5
Sugar maple	44,407	22,698	8,217	5,356	3,532	2,345	1,153	522	307	91	87	86	13
Red maple	59,118	28,861	12,030	7,255	5,232	2,947	1,448	687	315	213	73	47	10
Elm	428	288	-	81	49	-	10	-	-	-	-	-	-
Black ash	11,905	6,804	3,837	904	261	75	15	9	-	-	-	-	-
White and green ash	362	315	21	-	20	-	-	-	3	3	-	-	-
Balsam poplar	8,133	4,614	1,608	787	491	189	275	103	57	8	-	-	1
Bigtooth aspen	7,151	3,078	1,572	1,145	502	516	182	69	36	18	19	14	-
Quaking aspen	58,312	41,385	7,860	3,588	2,678	1,258	718	445	221	110	43	6	-
Paper birch	15,577	5,841	2,637	3,263	2,151	979	407	227	52	16	4	-	-
Black cherry	9,545	7,287	618	386	112	639	208	211	76	-	8	-	-
Noncommercial spp.	8,019	6,663	777	376	151	-	47	-	-	-	-	5	-
Total	237,322	132,508	41,679	24,900	17,184	9,847	5,192	2,997	1,550	753	376	307	29
All species	518,976	267,165	103,650	65,392	40,299	20,940	10,845	5,658	2,478	1,224	637	646	42

Table 7.- -Net volume of all live trees and growing-stock trees on timberland by Ranger District and major species group, Hiawatha National Forest, 1993

District	All live trees					Growing-stock trees				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	Thousand cubic feet					*Thousand cubic feet*				
Rapid River	194,460	27,392	57,765	66,678	42,625	173,177	26,914	53,543	56,470	36,250
Manistique	192,056	52,076	37,255	59,988	42,737	176,556	48,518	35,762	53,527	38,749
Munising	317,777	96,481	53,343	78,230	89,723	289,007	95,723	48,626	67,988	76,670
Sault Ste.Marie	275,082	94,827	81,578	77,712	20,965	248,844	90,924	74,717	66,050	17,153
St.Ignace	145,930	26,060	44,828	51,050	23,992	132,645	24,897	41,636	45,117	20,995
All Districts	1,125,305	296,836	274,769	333,658	220,042	1,020,229	286,976	254,284	289,152	189,817

Table 8.--Net volume of all live trees on timberland by species group and forest type, Hiawatha National Forest, 1993

(In thousand cubic feet)

Species group	All types	Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-soft maple	Maple-birch	Aspen	Paper birch	Balsam poplar
Softwoods															
Jack pine	81,058	62,737	7,355	1,049	585	-	2,849	-	-	4,194	-	158	2,131	-	-
Red pine	152,062	8,959	127,278	5,708	272	992	3,549	227	-	2,249	-	1,188	1,640	-	-
White pine	63,716	2,635	1,614	31,590	3,736	1,482	4,894	4,203	-	-	690	12,234	320	-	318
White spruce	23,627	156	314	-	3,003	7,318	2,599	2,392	-	-	1,749	3,201	1,924	-	971
Black spruce	40,142	1,621	399	4,474	1,514	-	14,307	9,854	-	-	2,989	1,892	3,092	-	-
Balsam fir	30,264	590	-	259	2,795	1,435	2,874	2,482	-	-	3,442	7,932	7,047	825	583
Hemlock	59,006	-	-	1,710	1,006	-	-	860	-	-	1,552	53,153	725	-	-
Tamarack	3,817	-	-	185	664	-	653	1,532	222	-	-	101	-	-	460
Northern white-cedar	117,913	-	379	44	2,403	1,135	944	94,988	-	-	5,592	7,109	1,272	-	4,047
Total	571,605	76,698	137,339	45,019	15,978	12,362	32,669	116,538	222	6,443	16,014	86,968	18,151	825	6,379
Hardwoods															
White oak	143	-	-	-	-	-	-	-	-	-	143	-	-	-	-
Red oak	4,120	-	-	-	-	456	-	-	-	3,069	-	595	-	-	-
Basswood	4,627	-	-	-	-	-	-	-	-	-	-	4,627	-	-	-
Beech	53,208	-	604	-	-	-	-	-	-	-	-	52,604	-	-	-
Yellow birch	34,436	-	-	-	276	-	-	2,698	-	-	656	30,806	-	-	-
Sugar maple	125,535	-	1,643	-	421	-	-	116	-	-	147	122,965	243	-	-
Red maple	149,866	206	1,405	1,094	1,454	978	1,175	1,940	-	556	7,095	130,401	3,231	-	331
Elm	499	-	-	-	-	-	-	-	-	-	205	176	118	-	-
Black ash	4,894	-	-	-	-	-	-	1,119	-	-	1,491	835	790	-	659
White and green ash	311	-	-	-	-	-	-	-	-	-	-	311	-	-	-
Balsam poplar	15,595	-	-	-	985	-	-	3,791	-	-	917	808	3,358	439	5,297
Bigtooth aspen	19,236	404	632	479	-	-	1,007	1,884	-	2,158	676	7,936	4,060	-	-
Quaking aspen	71,255	110	1,973	1,061	5,066	2,206	4,098	2,444	-	-	3,181	9,616	39,419	692	1,389
Paper birch	46,702	527	170	303	617	5,091	1,323	7,427	-	1,143	2,864	12,023	5,633	8,713	868
Black cherry	20,984	179	1,032	-	-	-	-	-	-	-	332	19,273	168	-	-
Noncommercial spp.	2,289	-	-	-	-	-	-	-	-	-	-	2,289	-	-	-
Total	553,700	1,426	7,459	2,937	8,819	8,731	7,603	21,419	-	6,926	17,707	395,265	57,020	9,844	8,544
All species	1,125,305	78,124	144,798	47,956	24,797	21,093	40,272	137,957	222	13,369	33,721	482,233	75,171	10,669	14,923

Table 9.--Net volume of growing-stock trees on timberland by species group and diameter class, Hiawatha National Forest, 1993

(In thousand cubic feet)

Species group	All classes	Diameter class (Inches at breast height) 5.0-6.9	7.0-8.9	9.0-10.9	11 12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
Jack pine	77,485	19,743	30,071	16,837	8,143	2,153	-	288	-	250	-
Red pine	150,930	11,166	18,322	35,156	40,934	27,978	9,065	3,034	2,331	2,944	-
White pine	58,561	2,223	4,242	5,663	6,417	6,052	7,072	5,823	5,691	13,590	1,788
White spruce	23,227	2,850	2,996	5,721	4,898	2,957	1,659	1,075	488	583	-
Black spruce	39,193	17,444	12,338	4,731	2,691	1,725	-	-	-	264	-
Balsam fir	30,070	9,839	10,513	7,160	1,423	390	312	433	-	-	-
Hemlock	55,027	1,979	3,607	3,874	7,625	9,557	4,943	7,281	4,804	10,565	792
Tamarack	3,459	1,139	468	287	273	657	434	-	201	-	-
Northern white-cedar	103,308	28,361	33,459	19,487	11,614	6,093	2,714	931	396	-	253
Total	541,260	94,744	116,016	98,916	84,018	57,562	26,199	18,865	13,911	28,196	2,833
Hardwoods											
White oak	143	-	-	143	-	-	-	-	-	-	-
Red oak	3,878	173	1,803	1,066	281	344	-	100	-	111	-
Basswood	4,078	336	1,462	1,186	788	306	-	-	-	-	-
Beech	41,960	2,144	3,245	2,372	5,650	10,444	6,922	5,010	1,758	4,415	-
Yellow birch	26,724	774	2,434	4,737	3,749	3,907	4,091	3,843	1,776	1,288	125
Sugar maple	116,881	14,892	21,065	24,726	19,611	11,477	9,659	3,681	4,357	6,884	529
Red maple	131,497	19,059	28,876	28,402	20,740	14,003	9,976	6,097	2,233	2,111	-
Elm	381	-	205	-	176	-	-	-	-	-	-
Black ash	4,391	2,025	1,381	538	254	193	-	-	-	-	-
White and green ash	231	-	134	-	-	-	-	97	-	-	-
Balsam poplar	14,428	1,715	2,397	1,837	3,590	2,683	1,855	279	-	-	72
Bigtooth aspen	17,027	2,162	3,129	4,627	2,759	1,140	908	805	1,099	398	-
Quaking aspen	60,806	8,730	14,361	11,706	7,686	7,276	5,812	3,551	1,477	207	-
Paper birch	40,149	8,277	10,784	9,515	5,528	4,244	1,169	402	230	-	-
Black cherry	16,395	456	697	5,469	3,119	4,402	2,065	-	187	-	-
Total	478,969	60,743	91,973	96,324	73,931	60,419	42,457	23,865	13,117	15,414	726
All species	1,020,229	155,487	207,989	195,240	157,949	117,981	68,656	42,730	27,028	43,610	3,559

Table 10.--Net volume of sawtimber on timberland by species group and diameter class, Hiawatha National Forest, 1993

(In thousand board feet) 1/

Species group	All classes	Diameter class (Inches at breast height) 9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Jack pine	135,045	80,651	40,234	11,136	-	1,587	-	1,437	-
Red pine	632,733	177,647	210,294	147,915	49,474	16,877	13,285	17,241	-
White pine	271,212	25,710	30,148	29,834	36,129	30,739	30,890	77,057	10,705
White spruce	92,508	29,225	25,508	16,073	9,205	6,166	2,817	3,514	-
Black spruce	50,118	24,603	14,394	9,522	-	-	-	1,599	-
Balsam fir	47,201	34,097	7,069	1,980	1,651	2,404	-	-	-
Hemlock	263,725	18,209	37,248	48,700	26,119	39,654	27,077	61,737	4,981
Tamarack	9,963	1,446	1,437	3,544	2,379	-	1,157	-	-
Northern white-cedar	210,641	96,961	58,870	31,584	14,445	5,055	2,198	-	1,528
Total	1,713,146	488,549	425,202	300,288	139,402	102,482	77,424	162,585	17,214
Hardwoods									
Red oak	3,632	-	1,094	1,514	-	469	-	555	-
Basswood	4,761	-	3,378	1,383	-	-	-	-	
Beech	166,070	-	24,732	49,189	34,135	25,373	9,147	23,494	-
Yellow birch	89,921	-	16,055	18,282	19,762	19,252	9,092	6,783	695
Sugar maple	254,158	-	81,245	50,755	44,989	17,759	21,569	35,008	2,833
Red maple	241,907	-	83,834	61,755	45,908	29,021	10,836	10,553	-
Elm	706	-	706	-	-	-	-	-	-
Black ash	1,965	-	1,094	871	-	-	-	-	-
White and green ash	460	-	-	-	-	460	-	-	-
Balsam poplar	37,995	-	15,309	12,198	8,745	1,362	-	-	381
Bigtooth aspen	33,186	-	12,016	5,276	4,321	3,965	5,569	2,039	-
Quaking aspen	119,165	-	32,896	33,156	27,398	17,333	7,329	1,053	-
Paper birch	49,330	-	22,489	18,517	5,338	1,882	1,104	-	-
Black cherry	43,069	-	13,006	19,570	9,574	-	919	-	-
Total	1,046,325	-	307,854	272,466	200,170	116,876	65,565	79,485	3,909
All species	2,759,471	488,549	733,056	572,754	339,572	219,358	142,989	242,070	21,123

1/ International 1/4-inch rule.

Table 11.--Net volume of growing stock and sawtimber on timberland by county and major species group, Hiawatha National Forest, 1993

County	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	Thousand cubic feet					*Thousand board feet 1/*				
Alger	202,459	73,478	25,904	49,646	53,431	682,804	336,166	126,930	89,896	129,812
Chippewa	238,598	90,924	70,085	60,857	16,732	574,986	263,954	149,344	116,359	45,329
Delta	274,213	58,981	74,810	83,833	56,589	625,200	166,219	163,021	155,420	140,540
Mackinac	142,891	24,897	46,268	50,310	21,416	386,214	116,882	133,247	80,509	55,576
Schoolcraft	148,031	38,696	37,217	39,531	32,587	449,352	155,769	101,614	77,727	114,242
Marquette	14,037	-	-	4,975	9,062	40,915	-	-	12,173	28,742
All counties	1,020,229	286,976	254,284	289,152	189,817	2,759,471	1,038,990	674,156	532,084	514,241

1/ International 1/4-inch rule.

Table 12.--Net volume of timber on timberland by class of timber and major species group, Hiawatha National Forest, 1993

(In thousand cubic feet)

Class of timber	All species	Major species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Live trees					
Growing-stock trees					
Sawtimber					
Saw-log portion	457,790	178,944	113,056	84,712	81,078
Upper stem portion	102,639	22,265	16,235	35,108	29,031
Total	560,429	201,209	129,291	119,820	110,109
Poletimber	459,800	85,767	124,993	169,332	79,708
All growing-stock trees	1,020,229	286,976	254,284	289,152	189,817
Cull trees					
Short-log trees	21,454	3,090	1,915	9,885	6,564
Rough trees					
Sawtimber	38,924	3,883	10,245	14,462	10,334
Poletimber	33,529	2,763	5,728	16,230	8,808
Total	72,453	6,646	15,973	30,692	19,142
Rotten trees					
Sawtimber	9,448	124	1,734	3,313	4,277
Poletimber	1,721	-	863	616	242
Total	11,169	124	2,597	3,929	4,519
All cull trees	105,076	9,860	20,485	44,506	30,225
All live trees	1,125,305	296,836	274,769	333,658	220,042
Salvable dead trees					
Sawtimber	21,405	2,777	4,453	14,112	63
Poletimber	5,491	1,632	2,133	1,726	-
Total	26,896	4,409	6,586	15,838	63
All classes	1,152,201	301,245	281,355	349,496	220,105

Table 13.--Average net annual growth of growing stock and sawtimber on timberland by county and major species group, Hiawatha National Forest, 1980-1992

County	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	Thousand cubic feet					*Thousand board feet 1/*				
Alger	5,058	2,470	415	1,043	1,130	23,416	13,696	2,692	3,282	3,746
Chippewa	5,877	3,415	1,025	985	452	20,494	12,051	2,399	4,201	1,843
Delta	8,186	2,469	2,496	2,007	1,214	26,523	8,553	7,673	4,357	5,940
Mackinac	3,724	928	1,028	1,177	591	15,280	4,620	4,766	3,996	1,898
Schoolcraft	3,367	1,276	844	732	515	13,752	7,145	1,944	2,709	1,954
Marquette	260	-	-	157	103	1,151	-	-	726	425
All counties	26,472	10,558	5,808	6,101	4,005	100,616	46,065	19,474	19,271	15,806

1/ International 1/4-inch rule.

Table 14.--Average annual removals of growing stock and sawtimber on timberland by county and major species group, Hiawatha National Forest, 1980-1992

County	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	Thousand cubic feet					*Thousand board feet 1/*				
Alger	1,436	571	129	454	282	3,906	1,979	323	720	884
Chippewa	4,197	551	1,689	1,482	475	7,555	1,677	2,632	1,160	2,086
Delta	4,197	889	2,214	726	368	11,325	626	8,246	1,249	1,204
Mackinac	2,585	1,460	449	563	113	3,380	2,281	234	593	272
Schoolcraft	693	372	132	189	-	1,657	744	545	368	-
Marquette	51	-	-	14	37	40	-	-	-	40
All counties	13,159	3,843	4,613	3,428	1,275	27,863	7,307	11,980	4,090	4,486

1/ International 1/4-inch rule.

Table 15.--Average net annual growth, average annual mortality, and average annual removals of growing stock and sawtimber on timberland by species group, Hiawatha National Forest, 1980-1992

Species group	Growing stock			Sawtimber		
	Average net annual growth	Average annual mortality	Average annual removals	Average net annual growth	Average annual mortality	Average annual removals
	Thousand cubic feet			*Thousand board feet 1/*		
Softwoods						
Jack pine	1,764	862	1,983	5,971	1,577	2,487
Red pine	6,875	9	1,524	30,456	99	3,105
White pine	1,919	92	336	9,638	295	1,715
White spruce	1,808	387	2,427	6,058	1,743	8,967
Black spruce	114	969	504	-1,077	1,768	900
Balsam fir	399	1,012	845	2,036	2,338	833
Hemlock	863	186	154	5,505	796	804
Tamarack	79	34	36	137	90	-
Northern white-cedar	2,545	317	647	6,815	930	476
Total	16,366	3,868	8,456	65,539	9,636	19,287
Hardwoods						
White oak	4	-	-	134	-	-
Red oak	79	9	-	315	11	257
Basswood	96	36	88	5,377	6	630
Beech	970	72	245	1,017	212	2,042
Yellow birch	-31	271	454	9,276	1,059	1,814
Sugar maple	2,983	333	576	9,118	839	1,674
Red maple	3,300	464	1,062	-26	468	-
Elm	-35	62	-	122	151	-
Black ash	140	37	-	2	-	-
Balsam poplar	170	547	116	117	1,644	-
Bigtooth aspen	418	198	272	1,275	276	497
Quaking aspen	1,419	1,332	938	6,769	2,333	448
Paper birch	317	591	614	412	858	1,016
Black cherry	276	67	338	1,169	155	198
Total	10,106	4,019	4,703	35,077	8,012	8,576
All species	26,472	7,887	13,159	100,616	17,648	27,863

1/ International 1/4-inch rule.

Table 16.--Volume of sawtimber on timberland by species group and butt log grade or tree grade, Hiawatha National Forest, 1993

(In thousand board feet) 1/

Species	All grades	Butt log grade 1	2	3	4
Softwoods					
Jack pine	135,045	-	-	135,045	-
Red pine	632,733	4,071	18,190	610,472	-
White pine	271,212	56,099	53,026	97,229	64,858
White spruce	92,508	-	1,733	90,775	-
Black spruce	50,118	-	-	50,118	-
Balsam fir	47,201	-	-	47,201	-
Hemlock	263,725	20,308	36,061	207,356	-
Tamarack	9,963	-	-	9,963	-
Northern white-cedar	210,641	-	-	210,641	-
Total	1,713,146	80,478	109,011	1,458,799	64,858

Species	All grades	Tree grade 1	2	3	Tie and timber
Hardwoods					
Red oak	3,632	-	1,664	-	1,968
Basswood	4,761	-	2,321	2,440	-
Beech	166,070	18,945	66,984	51,377	28,765
Yellow birch	89,921	10,485	38,744	34,731	5,961
Sugar maple	254,158	19,811	86,973	124,606	22,768
Red maple	241,907	18,254	69,880	123,852	29,920
Elm	706	-	-	706	-
Black ash	1,965	-	-	1,965	-
White and green ash	460	-	-	460	-
Balsam poplar	37,995	2,214	9,959	12,355	13,467
Bigtooth aspen	33,186	5,807	4,683	18,891	3,805
Quaking aspen	119,165	11,655	44,623	45,223	17,664
Paper birch	49,330	-	11,537	33,044	4,749
Black cherry	43,069	-	25,079	17,114	875
Total	1,046,325	87,172	362,446	466,765	129,942
All species	2,759,471	167,650	471,457	1,925,564	194,800

1/ International 1/4-inch rule.

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The inventory of the forest resources of the Hiawatha National Forest reports 892.1 thousand acres of land, of which 756.7 thousand acres are forested. This bulletin presents statistical highlights and contains detailed tables of forest area, as well as of timber volume, growth, removals, and mortality.

KEY WORDS: Forest area, timber volume, growth, removals, mortality.

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.